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[Inventor]

[Address] c/o Seiko Epson Corporation, 3-5, Owa 3-  
chome, Suwa-shi, Nagano-ken

[Name] Hiroyuki KOJIMA

[Inventor]

[Address] c/o Seiko Epson Corporation, 3-5, Owa 3-  
chome, Suwa-shi, Nagano-ken

[Name] Hiromi SAITOH

[Inventor]

[Address] c/o Seiko Epson Corporation, 3-5, Owa 3-  
chome, Suwa-shi, Nagano-ken

[Name] Tomoaki MIYASHITA

[Applicant for Patent]

[Id. No.] 000002369

[Name] Seiko Epson Corporation

[Agent]

[Id. No.] 100095728

[Patent Attorney]

[Name] Masataka KAMIYANAGI

[Phone No.] 0266-52-3139

[Sub-agent]

[Id. No.] 100107076

[Patent Attorney]

[Name] Eikichi FUJITSUNA

[Sub-agent]

[Id. No.] 100107261

[Patent Attorney]

[Name] Osamu SUZAWA

[Application Fees]

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[Name of Document] Specification 1

[Name of Document] Drawings 1

[Name of Document] Abstract 1

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[Name of Document] SPECIFICATION

[Title of the Invention] ELECTRO-OPTICAL DEVICE ENCASED  
IN MOUNTING CASE AND PROJECTION DISPLAY APPARATUS

[Claims]

[Claim 1] An electro-optical device encased in a mounting case having an image display region on which projection light from a light source is incident, the electro-optical device comprising:

a mounting case comprising a plate disposed to face one surface of the electro-optical device and a cover covering the electro-optical device, a portion of the cover abutting against the plate, the mounting case accommodating the electro-optical device by holding at least a portion of a peripheral region positioned at the circumference of the image display region of the electro-optical device with at least one of the plate and the cover,

wherein at least one of the plate and the cover is bonded to the electro-optical device by bonding means.

[Claim 2] The electro-optical device encased in the mounting case according to Claim 1,

wherein the bonding means includes at least one of a double coated adhesive tape and a mold material.

[Claim 3] The electro-optical device encased in the mounting case according to Claim 2,

wherein at least one of the double coated adhesive tape

and the mold material consists of a material having the heat conductivity of 0.6 [W/m·K] or more.

[Claim 4] The electro-optical device encased in the mounting case according to Claim 2 or 3,

wherein the double coated adhesive tape includes acryl rubber.

[Claim 5] The electro-optical device encased in the mounting case according to any one of Claims 1 to 4,

wherein at least one of the double coated adhesive tape and the mold material is provided to correspond to the whole peripheral region,

wherein at least one of the plate and the cover is bonded to the electro-optical device over the whole peripheral region.

[Claim 6] The electro-optical device encased in the mounting case according to any one of Claims 1 to 5,

wherein the thickness of the double coated adhesive tape is in the range of 50 to 200 [ $\mu$ m].

[Claim 7] The electro-optical device encased in the mounting case according to any one of Claims 1 to 6,

wherein at least one of an outmost surface of the plate and an outmost surface of the cover is black in color.

[Claim 8] The electro-optical device encased in the mounting case according to any one of Claim 7,

wherein a plating process is performed on at least one

of a surface of the plate and a surface of the cover.

[Claim 9] The electro-optical device encased in the mounting case according to Claim 8,

wherein the plating process is performed after performing a blast process on at least one of the surface of the plate and the surface of the cover.

[Claim 10] A projection display apparatus, comprising:

the electro-optical device encased in the mounting case according to any one of Claims 1 to 9;

the light source;

an optical system for guiding the projection light into the electro-optical device; and

a projection optical system for projecting the projection light emitted from the electro-optical device.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention belongs to a technical field of an electro-optical device encased in a mounting case in which an electro-optical device such as a liquid crystal panel, which is used as a light valve of a projection display apparatus such as a liquid crystal projector, is accommodated or encased in a mounting case and a projection display apparatus comprising the electro-optical device encased in the mounting case.

[0002]

[Description of the Related Art]

In general, when a liquid crystal panel is used as a light valve of a liquid crystal projector, the liquid crystal panel is not provided in an exposed state on a console, etc., constituting the liquid crystal projector, but it is accommodated or encased in a suitable mounting case, and then the liquid crystal panel encased in the mounting case is provided on the console. Herein, the liquid crystal panel can be easily attached and fixed to the console by suitable screw holes provided in the mounting case.

[0003]

In the liquid crystal projector, the light emitted from a light source is projected on the liquid crystal panel encased in the mounting case as focused light. Light passing through the liquid crystal panel is enlarged and projected on the screen to display images. In such a liquid crystal projector, since the enlarged projection is generally predetermined, relatively intensive light emitted from a light source such as a metal halide lamp is used.

[0004]

According to this constitution, first, there is a problem with the liquid crystal panel encased in the mounting case, particularly with the rise in temperature of

the liquid crystal panel. The rise in temperature causes the rise in temperature of the liquid crystal interposed between a pair of transparent substrates in the liquid crystal panel. Therefore, the characteristics of the liquid crystal are deteriorated. In addition, when the light emitted from the light source is uneven, the liquid crystal panel is partially heated, and then the deviation of transmittance of the liquid crystal is generated by the so-called hot spots. Thus, the quality of projected images deteriorates.

[0005]

As techniques for preventing the rise in temperature of the liquid crystal panel, for example, the techniques disclosed in Patent Document 1 have been known. In Patent Document 1, the techniques of preventing the rise in temperature of the liquid crystal panel by providing a heat radiating sheet between the liquid crystal panel and a heat radiating plate in a liquid crystal display module comprising the liquid crystal panel and a package (corresponding to "mounting case" of the specification) for holding and accommodating the liquid crystal panel and for having the heat radiating plate are disclosed.

[0006]

In addition, in order to solve the problem, other techniques, such as a technique of providing a light

shielding film on a substrate located at the side of the liquid crystal panel on which light is incident and a technique of using the mounting case made of a light reflective material, in which the liquid crystal panel is held or accommodated, have been known.

[0007]

[Patent Document 1]

Japanese Translation of PCT International Application  
WO98/36313

[0008]

[Problems to be Solved by the Invention]

However, the conventional approaches for preventing the rise in temperature of the liquid crystal panel have the problems as follows. That is, as long as intensive light is emitted from the light source, the problem of the rise in temperature of the liquid crystal panel may occur at any time. Therefore, in order to obtain still higher image quality, the more effective measures to prevent the rise in temperature are required instead of or in addition to the aforementioned approaches.

[0009]

Further, there is following difficulty for each approach for preventing the rise in temperature as described above. That is, according to the approach of using the heat radiating sheet disclosed in Patent Document 1, while it may



be clearly thought that heat accumulation in the liquid crystal panel can effectively radiate outward, there is no effective action to decide a position of the liquid crystal panel in a package. Namely, using the heat radiating seat, while the rise in temperature of the liquid crystal panel will definitely cause the rise in temperature of the package, it may be though that the dislocation of the liquid crystal panel in the package occur due to the difference in coefficients of linear expansion between the heat radiating sheet and the package. However, approaches to this problem are not disclosed in Patent Document 1. In Patent Document 1, there is also disclosed that "the preventing of breakages caused by the heat expansion" of both of the heat radiating sheet and the package (from a 23rd line to a 25th line in Page 7). However, there is disclosed that "a gap may be generated" (from the 23rd line to the 25th line in Page 7) as an approach thereof. Accordingly, it can be sad that the approach thereof is not good from a viewpoint of understanding the dislocation as a problem.

[0010]

Moreover, as using the heat radiating "plate" or the heat radiating "sheet" in Patent Document 1 and as shown in Fig. 2 of Patent Document 1, it is assumed that the heat radiating sheet is provided to cover the whole surface of a substrate, they may be useless for a transmissive liquid

crystal panel although being used for a reflective liquid crystal panel.

[0011]

In addition, according to the approach of reflecting light by the light shielding film and the mounting case, as the areas of the light shielding film and the mounting case increase, the amount of the reflected light increases. Thus, the rise in temperature of the liquid crystal panel can be surely prevented. However, if the amount of the reflected light increases indiscriminately, the stray light increases in the housing for accommodating the liquid crystal panel in the mounting case. Thus, the quality of images can be deteriorated. In addition, since the increase of the area of the light shielding film causes the reduction of the amount of the light emitted from the light source, which is to be originally incident to and to pass through the liquid crystal panel, the image can be dark. Thus, it is contrary to the aforementioned purpose in which the intensive light emitted from the light source is used in order to display brighter image. Accordingly, the aforementioned approaches do not have radical solutions for the above problems.

[0012]

The present invention is contrived to solve the above-mentioned problem. An object of the present invention is to

provide an electro-optical device encased in a mounting case capable of, if possible, preventing an electro-optical device from deviating from its location, an electro-optical device encased in a mounting case capable of efficiently depressing the rise in temperature of an electro-optical device on which relatively intense projection light is incident, and a projection display apparatus including such a device.

[0013]

[Means for Solving the Problems]

In order to solve the problems, an electro-optical device encased in a mounting case according to the invention includes an electro-optical device having an image display region, on which projection light from a light source is incident, and a mounting case comprising a plate disposed to face one surface of the electro-optical device and a cover for covering the electro-optical device, a portion of the cover abutting against the plate, wherein the mounting case accommodates the electro-optical device by holding at least a portion of a peripheral region located in the circumference of the image display region of the electro-optical device with at least one of the plate and the cover. Furthermore, the electro-optical device is bonded to at least one of the plate and the cover by bonding means.

[0014]

According to the electro-optical device encased in the mounting case of the present invention, the electro-optical device having the image display region, on which the projection light from the light source is incident, is accommodated into the mounting case comprising the plate and the cover. The electro-optical device includes, for example, a liquid crystal device or a liquid crystal panel which is mounted as a light valve of the projection display apparatus. In addition, the mounting case may have a light shielding function for preventing the leakage of light in the peripheral region of the electro-optical device and the influx of the stray light from the peripheral region to the image display region by partially covering at least a portion of the peripheral region of the electro-optical device.

[0015]

Then, the electro-optical device is bonded to at least one (hereinafter, a plate is simply referred to as a representative in the description about the present invention and various aspects thereof) of the plate and the cover by bonding means. As a result, first, because the bonding between both sides can be definitely made owing to the adhesive strength of the bonding means, it is possible to effectively prevent a situation in which the positional deviation of electro-optical device in the mounting case

occurs. In particular, when the electro-optical device encased in the mounting case is constructed into a projection display apparatus such as a liquid crystal projector, etc., it is considered that relatively great tension acts on a flexible connector extending from the electro-optical device. However, in the present invention, since the bonding means exists, there can be obtained an advantage that the positional deviation of the electro-optical device encased in the mounting case does not simply occur although the relatively great tension acts on the flexible connector.

[0016]

Further, if such bonding means has reasonable thermal conductivity, it is possible to favorably implement heat transfer from the electro-optical device to the plate. Thus, when the temperature of the electro-optical device rises due to light incident on the electro-optical device from a light source, it is possible to efficiently transfer the heat to the plate via the bonding means.

[0017]

As described above, in accordance with the present invention, it is possible to obtain two effects, i.e., the fixation (adhesion) of the electro-optical device to the mounting case and the efficient cooling of the electro-optical device.

[0018]

In an aspect of the electro-optical device encased in a mounting case according to the present invention, the bonding means includes at least one of a double coated adhesive tape and a mold material.

[0019]

In accordance with such aspect, the bonding means includes at least one of the double coated adhesive tape and the mold material. Herein, the double coated adhesive tape means a tape in which each of the front and back surfaces has adhesive power, and the mold material means an adhesive made of, e.g., silicon resin. In this regard, it is possible to easily fix (bond) the plate to the electro-optical device.

[0020]

Further, in the present aspect, it is possible to variously set the specific shape of "the double coated adhesive tape" or the shape of a region to which the mold material is applied (namely, the shape of a region where the adhesion acts between the plate and the electro-optical device). For instance, as will be described below, the double coated adhesive tape or the mold material is provided to correspond the whole peripheral region, so that the electro-optical device can be bonded to the plate in the whole peripheral region.

[0021]

Moreover, the double coated adhesive tape or the mold material is provided along each of two sides, which are opposite to each other, of a substrate constituting an electro-optical device, i.e., in a stripe shape, so that the electro-optical device can be bonded to the plate. In addition, when the electro-optical device is a liquid crystal display device, "the substrate constituting an electro-optical device" includes, for example, a pair of substrates arranged to face each other with a liquid crystal layer (more particularly, a TFT array substrate, in which thin film transistors as switching elements are formed in a matrix, and a counter substrate), or a dust-proof substrate, which is provided on the side not facing the liquid crystal layer of any one or both of such pair of substrates. Further, it should be typically considered that the direct bonding of the double coated adhesive tape or the mold material is executed on such pair of substrates or such dust-proof substrate, etc (that is, typically "the adhesion between an electro-optical device and a plate" corresponds to "the adhesion between a substrate constituting an electro-optical device and a plate").

[0022]

As described above, in accordance with a case where the double coated adhesive tape is provided at only the

peripheral region, it is possible to properly realize the bonding of the electro-optical device to the plate although the electro-optical device according to the present invention is what is called "a transmissive type".

[0023]

However, in the present invention, it could not be positively excluded that a specific shape of the double coated adhesive tape is almost equal to the area of the substrate. Thus, such a case can also be available if only "electro-optical device" according to the present invention is a reflective type.

[0024]

In an aspect of an electro-optical device encased in a mounting case according to the present invention, at least one of the double coated adhesive tape and the mold material is made of a material having the heat conductivity of 0.6 [W/m·K] or more.

[0025]

In accordance with such an aspect, because at least one of the double coated adhesive tape and the mold material is made of a material having the heat conductivity of 0.6 [W/m·K] or more, the heat transferred from the electro-optical device to the double coated adhesive tape or the mold material is rapidly transferred to the plate again. Thus, in accordance with such an aspect, it is possible to



more effectively cool the electro-optical device.

[0026]

Further, "double coated adhesive tapes" satisfying such requirements includes, for example, a double coated adhesive tape which contains heat conductive silicon rubber, a double coated adhesive tape which contains the heat conductive silicon rubber and has a multi-layered structure in which the materials of a bonding layer and a layer to be bonded are changed, and the like. In addition, for example, silicon RTV rubber is used as the "mold material".

[0027]

In another aspect of the electro-optical device encased in the mounting case according to the present invention, a double coated adhesive tape includes acryl rubber.

[0028]

In accordance with such an aspect, the double coated adhesive tape according to the present invention includes not the silicon rubber as described above but the acryl rubber as a main body, and has a structure capable of including metal oxide or metal nitride. Such a double coated adhesive tape may be what is called an acryl-based heat conductive double coated adhesive tape and has very excellent heat conductivity. Specifically, it is possible to attain the heat conductivity of 1.0 [W/m·K] or more.

[0029]

Accordingly, in accordance with the present invention, it is possible to effectively cool the electro-optical device.

[0030]

In another aspect of the electro-optical device encased in the mounting case according to the present invention, at least one of the double coated adhesive tape and the mold material is provided to correspond to the whole peripheral region, and at least one of the plate and the cover is bonded to the electro-optical device over the whole peripheral region.

[0031]

In accordance with such an aspect, it is possible to realize the bonding of the plate to the electro-optical device securely and tightly. Further, as the contact area with the double coated adhesive tape or the mold material is increased, heat is efficiently transferred from the electro-optical device to the plate. Thus, it is possible to efficiently cool the electro-optical device. Furthermore, as described above, because the electro-optical device is bonded to the plate over the whole peripheral region, it is possible to easily enhance adhesion power if the size (wherein screen size [inch] is considered as the reference) of the electro-optical device is relatively small.

[0032]

In accordance with another aspect of the electro-optical device encased in the mounting case according to the present invention, the double coated adhesive tape has a thickness of 50 to 200  $\mu\text{m}$ .

[0033]

According to such an aspect, since the thickness of the double coated adhesive tape is defined to very suitable thickness, it is possible to definitely bond the electro-optical device to the plate described above, and to effectively transfer heat from the former to the latter.

[0034]

Namely, when the thickness of the double coated adhesive tape is less than 50 [ $\mu\text{m}$ ], because of unevenness ("unevenness" mentioned above due to an inherent rugged surface of an original material constituting the plate) on the surface of the plate, a portion of the double coated adhesive tape is buried in the concave portions of the unevenness, and thus the whole surface of the double coated adhesive tape is not bonded to a substrate constituting the electro-optical device. As a result, because the gap between the substrate and the plate is generated due to the unevenness, heat transfer efficiency between them also decreases. In accordance with the present aspect, because the thickness of the double coated adhesive tape is not less than 50 [ $\mu\text{m}$ ], such a problem hardly occurs.

[0035]

On the other hand, when the thickness of the double coated adhesive tape is more than 200 [ $\mu\text{m}$ ], the adhesion between the plate and the double coated adhesive tape and the adhesion between the substrate constituting the electro-optical device and the double coated adhesive tape are effectively accomplished respectively. However, the relative positional disparity between the two occurs due to the inherent elasticity of the double coated adhesive tape. In addition, the greater the thickness of the double coated adhesive tape increases, the longer a heat transfer path lengthens. As a result, it could be considered that heat transfer efficiency decreases. In accordance with the present aspect, because the thickness of the double coated adhesive tape is not more than 200 [ $\mu\text{m}$ ], such a problem hardly occurs.

[0036]

As described above, because the thickness of the double coated adhesive tape according to the present aspect is limited to the range of 50 to 200 [ $\mu\text{m}$ ], it is possible to realize the bonding of the plate to the electro-optical device securely and the transferring of the heat from the former to the latter efficiently.

[0037]

In accordance with another aspect of an electro-optical

device encased in a mounting case according to the present invention, at least one of the outmost surface of the plate and the outmost surface of the cover is black in color.

[0038]

In accordance with such an aspect, since the outmost surface of the plate is black in color, it is possible to make every effort to depress light reflection from the outmost surface. Herein, when the outmost surface with black color includes a light incidence surface of the plate, it is possible to prevent an undesired situation where light is incident on the electro-optical device from a light emitting part of the electro-optical device because the reflection from the surface is prevented. As a result, when an electro-optical device comprises a substrate including a semiconductor device in which characteristics thereof vary with so-called light leak current, it is possible to previously prevent light incidence on the semiconductor and to preferably maintain the characteristics. Further, as described above, it is possible to evade a situation where reflected light is reflected on the electro-optical device, etc. again and thus the light is finally mixed into images.

[0039]

On the other hand, when the outmost surface includes a light-emitting surface of the plate, it is prevented that light is reflected from the surface. Specifically, it is

prevented that the light emitted from an electro-optical device encased in a mounting case is reflected from any element (for example, a dichroic prism in a case where the electro-optical device encased in the mounting case is mounted in a liquid crystal projector) provided on the outside, and then the reflected light is reflected from the light emitting surface. Thus, it is possible to evade a situation where such reflected light is mixed into images.

[0040]

As described above, in accordance with the present aspect, generally, because light reflection from the plate is depressed, it is possible to display high-quality images using the electro-optical device encased the mounting case.

[0041]

In addition, in order to make the outmost surface of the plate with black color, for example, it is preferable to perform a plating process or a coating process on the surface of the plate as will be described below. Further, as clear above, the "outmost surface" in the present invention does not mean the "whole" outmost surface of the plate. The "outmost surface" denotes "at least a portion" of the outmost surface of the plate.

[0042]

In such an aspect, it is preferable that a plating process be performed on at least one of the surface of the

plate or the surface of the cover.

[0043]

According to such configuration, the surface of the plate is plated with Ni (nickel), Cr (chrome), or Zn (zinc), etc., so that the outmost surface of the plate can have black color. In this way, as compared with the plate of which the outmost surface is black in color through a painting process, the adhesion between the plate and the double coated adhesive tape can be made stronger. In case of painting, paint is easily exfoliated from the surface of the plate. Thus, although the paint is tightly bonded to the double coated adhesive tape, there is a possibility that the paint may be exfoliated from the surface of the plate. However, in the present aspect, there is no such trouble because the outmost surface is black in color through a plating process.

[0044]

As described above, in accordance with the present aspect, the plate is securely and tightly bonded to the double coated adhesive tape, so that the plate can be securely and tightly bonded to the electro-optical device.

[0045]

In such configuration, it is preferable that the above-described plating process be performed after performing a blast process on at least one of a surface of the plate and

a surface of the cover.

[0046]

According to such configuration, the above-described plating process may be performed on the surface of the plate on which the blast process is performed. Herein, the blast process is a process where particles, such as iron, sand, glass, etc., are stuck to a surface of any material, thereby making the surface rough (The rough surface subjected to such a blast process may be called a "crepe surface".). In general, because the blast-processed surface of the plate is uneven in disorder, it is possible to effectively achieve the operation of preventing the light reflection as described above.

[0047]

In order to solve the problems, a projection display apparatus of the present invention includes the aforementioned electro-optical device encased in the mounting case (including their various aspects); the light source; an optical system for guiding the projection light into the electro-optical device; and a projection optical system for projecting the projection light emitted from the electro-optical device.

[0048]

In accordance with such an aspect, the plate is bonded to the electro-optical device by a double coated adhesive



tape or a mold material. Thus, the plate can be securely fixed (bonded) to the electro-optical device, and heat can be efficiently transferred from the electro-optical device to the plate. As a result, the dislocation occurrence of the electro-optical device encased in the mounting case can be previously prevented, and the electro-optical device can be effectively cooled. Thus, higher-quality images can be displayed.

[0049]

The operations and other advantages of the present invention will be apparent from the embodiments described later.

[0050]

[Description of the Embodiments]

Now, embodiments of the present invention will be described with reference to the accompanying drawings.

[0051]

(An embodiment of a projection liquid crystal apparatus)

Firstly, with reference to Fig. 1, an embodiment of a projection liquid crystal apparatus according to the present invention will be described on the basis of an optical system into which optical units are assembled. The projection display apparatus of the embodiment is constructed as a multi-plate color projector composed of three liquid light valves, which is an example of an

electro-optical device encased in a mounting case.

[0052]

In Fig. 1, a liquid crystal projector 1100, an example of the multi-plate color projector according to the present embodiment, is a projector which utilizes three liquid crystal light valves having electro-optical devices in which driving circuits are mounted on TFT array substrates as RGB light valves 100R, 100G, and 100B.

In the liquid crystal projector 1100, the light emitted from a lamp unit 1102, which is a white light source, such as a metal halide lamp is divided into R, G, and B light components corresponding to three primary colors R, G, and B by three mirrors 1106 and two dichroic mirrors 1108, and the light components are guided into the light valves 100R, 100G, and 100B corresponding to the colors. In particular, the B light component is guided through a relay lens system 1121 comprising an incident lens 1122, a relay lens 1123, and an emitting lens 1124 in order to prevent the loss of light due to its long optical path. The light components corresponding to the three primary colors, which are modulated by the light valves 100R, 100G, and 100B, are synthesized by a dichroic prism 1112 and then projected on the screen 1120 as a color image through a projection lens 1114.

[0053]

For example, an active matrix driving liquid crystal apparatus, in which TFTs are used as switching devices, is used as the light valves 100R, 100G, and 100B of the embodiment as described later. The light valves 100R, 100G, and 100B are constituted as the electro-optical devices encased in the mounting cases as described later in detail.

[0054]

Further, as shown in Fig. 1, a sirocco fan 1300 for sending cooling air to light valves 100R, 100G, and 100B is provided in such a liquid crystal projector 1100. The sirocco fan 1300 comprises a substantially cylindrical member having a plurality of blades 1301 in the side thereof, and the blades 1301 generate wind by rotating the cylindrical member with its axis as a center. The wind generated by the sirocco fan 1300 in accordance with such a principle flows in whirls as shown in Fig. 1.

[0055]

The wind is supplied to the respective light valves 100R, 100G, and 100B through an air passage not shown in Fig. 1, and blows from respective outlets 100RW, 100GW, and 100BW provided near the light valves 100R, 100G, and 100B to the light valves 100R, 100G, and 100B.

[0056]

If the sirocco fan 1300 as described above is used, it is possible to obtain an advantage that the wind is easily

supplied to narrow spaces around the light valves 100R, 100G, and 100B because the wind has a high static pressure.

[0057]

In the aforementioned construction, projection light from the lamp unit 1102, which is an intensive light source, raises the temperatures of the light valves 100R, 100G, and 100B. In this case, if the temperature is raised excessively, the liquid crystal constituting the respective light valves 100R, 100G, and 100B is deteriorated, or deviation of transmittance of the liquid crystal is generated by hot spots generated by partial heating of the liquid crystal panel due to unevenness of light from a light source. Thus, in the present embodiment, particularly, each of light valves 100R, 100G, and 100B is bonded to the electro-optical device and the plate constituting a mounting case by a double coated adhesive tape having relatively excellent heat conductivity as will be described below. Therefore, it is possible to effectively suppress the rise in temperature of the light valves 100R, 100G, and 100B as described later.

[0058]

In the embodiment, it is preferable that cooling means comprising a circulating unit for flowing a coolant through the surrounding spaces of the light valves 100R, 100G, and 100B should be provided within a housing of the liquid

crystal projector 1100. In this way, it is possible to further effectively cool the electro-optical device encased in the mounting case having a heat radiating function as described later.

[0059]

(An embodiment of an electro-optical device)

Next, the overall construction of an electro-optical device according to an embodiment of the present invention will be described with reference to Figs. 2 and 3. Herein, a driving circuit built-in TFT active driving liquid crystal device is illustrated as an example of an electro-optical device. The electro-optical device according to the embodiment is used as liquid light valves 100R, 100G, and 100B of the aforementioned liquid crystal projector 1100. Herein, Fig. 2 is a plan view of the electro-optical device and illustrates a TFT array substrate and constructional components provided thereon as shown from the counter substrate. Fig. 3 is a cross-sectional view taken along the line H-H' shown in Fig. 2.

[0060]

Referring to Figs. 2 and 3, in the electro-optical device according to the embodiment, the TFT array substrate 10 is disposed to face the counter substrate 20. A liquid crystal layer 50 is interposed and sealed between the TFT array substrate 10 and the counter substrate 20. The TFT

array substrate 10 and the counter substrate 20 are bonded to each other by a seal member 52 disposed at a seal region which is located around an image display region 10a.

[0061]

The seal member 52 for bonding both substrates is made of, for example, ultra-violet curable resin, thermosetting resin, and the like, which are applied on the TFT array substrate 10 and then cured by ultra-violet irradiation or heating in manufacturing processes. In addition, spacers made of a material such as glass fiber or glass bead are dispersed in the seal member 52 to keep the gap between the TFT array substrate 10 and the counter substrate 20 (the gap between the substrates) at a predetermined interval. Therefore, the electro-optical device of the embodiment is used for a light valve of the projector as a small-sized device and is suitable for enlarging and displaying images.

[0062]

A frame light shielding film 53 for defining a frame region of the image display region 10a is provided at the counter substrate 20 parallel to the inner side of the seal region where the seal member 52 is disposed. All or a portion of the frame light shielding film 53 may be provided at the TFT array substrate 10 as a built-in light shielding film.

[0063]

In the peripheral region located at the outer side of the seal region, where the seal member 52 is disposed, of a region extending to the circumference of the image display region, a data line driving circuit 101 and an external circuit connection terminal 102 are provided along one side of the TFT array substrate 10, and scanning line driving circuits 104 are provided along two sides adjacent to the one side. Furthermore, a plurality of wiring lines 105 for connecting the scanning line driving circuits 104 provided along two sides of the image display region 10a is provided at the remaining side of the TFT array substrate 10. As shown in Fig. 2, upper and lower conducting members 106 for serving as upper and lower conduction terminals between the two substrates are disposed at four corners of the counter substrate 20. On the other hand, on the TFT array substrate 10, the upper and lower conduction terminals are provided at the regions opposite to the corners. Through these members, the electrical conduction is made between the TFT array substrate 10 and the counter substrate 20.

[0064]

In Fig. 3, pixel-switching TFTs and wiring lines such as scanning lines and data lines are formed on the TFT array substrate 10, and then, alignment layers are formed on a pixel electrode 9a. On the other hand, on the counter substrate 20, a counter electrode 21 and a light shielding

film 23 in a lattice or stripe shape are provided, and in addition, an alignment layer is formed on the uppermost portion thereof. A liquid crystal layer 50, which is made of, for example, one kind of nematic liquid crystal or a mixture of plural kinds of nematic liquid crystal, takes a predetermined alignment state between a pair of alignment layers.

[0065]

In addition to the data line driving circuit 101 and the scanning line driving circuits 104, etc., a sampling circuit for sampling image signals on image signal lines and for supplying the sampled image signals to data lines, a precharge circuit for supplying the precharge signals of a predetermined voltage level to a plurality of data lines prior to the image signals, and an inspection circuit and the like for inspecting the quality and defects of the electro-optical device during the manufacturing process or at the time of forwarding may be formed on the TFT array substrate 10 shown in Figs. 2 and 3.

[0066]

When the electro-optical device as constructed above is operated, intensive projection light is radiated from the upper side of Fig. 3. As a result, the temperature of the electro-optical device rises by the heating due to the light absorption in the counter substrate 20, the liquid crystal



layer 50, and the TFT array substrate 10, etc. The rise in temperature facilitates the deterioration of the liquid crystal layer 50 and causes the deterioration of the quality of the display image.

[0067]

Therefore, the rise in temperature can be effectively suppressed by the electro-optical device encased in the mounting case of the embodiment described below.

[0068]

(An electro-optical device encased in a mounting case)

Next, an electro-optical device encased in the mounting case according to an embodiment of the present invention will be described with reference to Figs. 4 to 11.

[0069]

Herein, a basic construction of the mounting case according to the embodiment is described with reference to Figs. 4 to 11. Fig. 4 is an exploded perspective view illustrating the electro-optical device together with the mounting case according to the present embodiment, Fig. 5 is a front view of the electro-optical device encased in the mounting case, Fig. 6 is a cross-sectional view taken along the line X1-X1' shown in Fig. 5, Fig. 7 is a cross-sectional view taken along the line Y1-Y1' shown in Fig. 5, and Fig. 8 is a back view shown from the direction of Z1 shown in Fig. 5. Furthermore, Fig. 9 is a front view of a plate member

constituting the mounting case, Fig. 10 is a back view shown from the direction of Z2 shown Fig. 9, and Fig. 11 is a side view shown from the direction of Z3 shown Fig. 9. Moreover, Figs. 4 to 8 illustrate the mounting case in which the electro-optical devices are accommodated.

[0070]

As shown in Figs. 4 to 8, the mounting case 601 comprises the plate member 610 and the cover member 620. The electro-optical device 500, which is accommodated in the mounting case 601, comprises another optical component such as a reflection preventing plate overlapped with the surface thereof, and an external circuit connecting terminal, to which a flexible connector 501 is connected, in addition to the electro-optical devices shown in Figs. 2 and 3. Furthermore, a polarizing plate or a phase difference plate may be provided to the optical system of the liquid crystal projector 1100, or it may be overlapped with the surface of the electro-optical device 500.

[0071]

Moreover, a dust-proof substrate 400 is provided to portions not facing the liquid crystal layers 50 in the TFT array substrate 10 and the counter substrate 20 (see Figs. 4 and 6). The dust-proof substrate 400 is constructed to have a predetermined thickness. The dust-proof substrate prevents dirt or dust around the electro-optical device 500

from being directly stuck onto the surface of the electro-optical device. Therefore, it is possible to effectively remove a defect that a figure of dirt or dust appears on the magnified projection image. Since the dust-proof substrate 400 has the predetermined thickness, the focusing point of the source light or the vicinity thereof is deviated from locations where dirt or dust exists (that is, from the surface of the dust-proof substrate 400) (defocusing function).

[0072]

As shown in Fig. 4, the electro-optical device 500 comprising the TFT array substrate 10, the counter substrate 20, and the dust-proof substrate 400 is accommodated in the mounting case 601 comprising the plate member 610 and the cover member 620. However, as shown in Figs. 6 and 7, a molding member 630 is filled between the electro-optical device 500 and the mounting case 601. The molding member 630 ensures the bonding between the electro-optical device 500 and the mounting case 601 and surely prevents the occurrence of positional deviation of the electro-optical device 500 within the mounting case 601.

[0073]

In the present embodiment, it is assumed that the light is incident on the cover member 620, passes through the electro-optical device 500, and emits from the plate member

610. That is, referring to the Fig. 1, the component facing the dichroic prism 1112 is not the cover member 620 but the plate member 610.

[0074]

Now, the construction of the plate member 610 and the cover member 620 constituting the plate member 610 will be described in more detail.

[0075]

Firstly, as shown in Figs. 4 to 11, the plate member 610 is a member having a substantially quadrilateral shape in plan view and is disposed to face one surface of the electro-optical device 500. In the first embodiment, the plate member 610 and the electro-optical device 500 are directly abutted against each other, and the latter is mounted on the former.

[0076]

More specifically, the plate member 610 comprises a window 615, a strength reinforcement portion 614, a bent portion 613, a cover-member-fixing hole 612, and attaching holes 611a to 611d and 611e.

[0077]

The window 615 is formed in an opened shape in which a portion of the member having the substantially quadrilateral shape is opened. For example, the window 615 is a member for enabling the light to transmit from the upper side to

the lower side in Fig. 6. The light can pass through the electro-optical device 500 by the window 615. When the electro-optical device 500 is mounted on the plate member 610, the peripheral region around the image display region 10a in the electro-optical device 500 is in an abutting state against the edge of the window 615. Moreover, in this regard, according to the present embodiment, particularly, a double coated adhesive tape 1 is provided around the border or the peripheral region of the window 615, and a plate member 610 are bonded to an electro-optical device 500 by such a double coated adhesive tape 1. These points will be described below.

[0078]

The bent portion 613 is a portion formed by bending a portion of each of two opposite sides of the member having the substantially quadrilateral shape toward the inside of the quadrilateral shape. The outer surface of the bent portion 613 is abutted against the inner surface of the cover member 620 when bonding the plate member 610 to the cover member 620 (see Fig. 6). The inner surface of the bent portion 613 is abutted against the outer surface of the electro-optical device 500 through the molding member 630 (see Fig. 6). In this manner, the location of the electro-optical device 500 on the plate member 610 is roughly determined.

[0079]

In addition, since the inner surface of the bent portion 613 is abutted against the outer surface of the electro-optical device 500 through the molding member 630, the absorption of heat from the former to the latter is available. In other words, the plate member 610 can function as a heat sink for the electro-optical device 500. Thus, it is possible to prevent the accumulation of heat in the electro-optical device 500 due to the intensive light radiation from the lamp unit 1102 to the electro-optical device 500. In addition, since the outer surface of the bent portion 613 is abutted against the inner surface of the cover member 620 as described above, the heat transfer from the former to the latter is available. The heat radiation from the electro-optical device 500 is performed by the amount corresponding to heat capacitances of both of the plate member 610 and the cover member 620, so that the cooling of the electro-optical device 500 can be very effectively performed.

[0080]

The strength reinforcement portion 614 has a three-dimensional shape formed by a process of convexing a portion of the member having the substantially quadrilateral shape higher than other portions in plan view. In this way, the strength of the plate member 614 is reinforced. The

strength reinforcement portion 614 may be disposed at a location to substantially abut against one side of the electro-optical device 500 (see Fig. 7. However, strictly speaking, both of them are not abutted against each other in Fig. 7.)). In this regard, the position of the electro-optical device 500 on the plate member 610 is decided to some degree by such a strength reinforcement portion 614 as well as a bent portion 613.

[0081]

The cover-member-fixing hole portion 612 is a hole portion for being engaged with a convex portion 621 provided at the corresponding location in the cover member 620. The plate member 610 and the cover member 620 are fixed to each other by engaging the cover-member-fixing hole portion 612 with the convex portion 621. In addition, in the present embodiment, the cover-member-fixing hole portion 612 comprises two holes as shown in each figure (In case of the need of distinguishing the holes, the two holes are referred to as cover-member-fixing holes 612a and 612b, respectively.)). Corresponding to the holes, the convex portion 621 comprises two convex portions (In case of the need of distinguishing the convex portions, the two convex portions are referred to as convex portions 621a and 621b, respectively.)).

[0082]

The attaching holes 611a to 611d are used for attaching the electro-optical device encased in the mounting case within the liquid crystal projector 1100 as shown in Fig. 1. In the present embodiment, the attaching holes 611a to 611d are provided to four corners of the member having the substantially quadrilateral shape. In addition to the attaching holes 611a to 611d, an attaching hole 611e is provided in the present embodiment. The attaching hole 611e is disposed to form a triangle together with the attaching holes 611c and 611d of the attaching holes 611a to 611d (In other words, the attaching holes 611e, 611c, and 611d are disposed as the corresponding apexes of the triangle.). In this manner, in the present embodiment, it is possible to fix the four points at the four corners using the attaching holes 611a to 611d and to fix the three points at the three corners using the attaching holes 611e, 611c, and 611d.

[0083]

Then, particularly, in the present embodiment, such a plate member 610 has the following feature. Namely, the plate member 610 according to the present embodiment has the outmost surface with black color. Herein, the "outmost surface" is a paint-coated surface by a painting when the surface of the plate member 610 is coated with black color. Further, the 'outmost surface,' which is a portion of the plate member 610, includes, for example, a light-emitting



surface of the plate member 610, and the light-emitting surface is, for example, a surface, which is shown in Fig. 10 or 11 and is indicated as a reference numeral 610F (In addition, as not shown in Fig. 9, the surface corresponds to the back of a paper.). Moreover, it is preferable that the "outmost surface" should also include a light incident surface opposite thereto (The outmost surface corresponds to the surface shown in Fig. 9.).

[0084]

As described above, since the outmost surface of the plate member 610 is black in color, useless light reflection from the plate member 610 can be prevented. Thus, it is possible to improve image quality. For instance, as described above, when the light emitting surface 610F is black in color, it is possible to previously prevent a situation where the light transmitted through (the window 615) of the plate member 610 or light, from the viewpoint of one of light valves 100R, 100G, and 100B shown in Fig. 1, emitted from other two valves and incident on the one is reflected from the light-emitting surface 610F of the plate member 610 and then the useless reflected light is mixed into projection images. Alternatively, when the surface of light incident part is black in color, it is possible to prevent a situation where light is incident on the electro-optical device from a light-emitting surface of the electro-

optical device, the situation not occurring from the first. As a result, it is possible to previously prevent light incidence on TFTs built on a TFT array substrate constituting an electro-optical device, thereby enabling characteristics thereof to be maintained. Further, as described above, it is possible to evade a situation where the reflected light is reflected from the electro-optical device, etc. again and thus the light is finally mixed into images.

[0085]

As described above, in accordance with the present embodiment, it is possible to display higher-quality image without the deterioration of image quality.

[0086]

Further, in order to form the light-emitting surface 610F with black color, it is possible to use, for example, means for coating black paint or means for painting with proper metal such as nickel, chrome, and zinc which will be described later, and other means or structures.

[0087]

Next, the cover member 620, which is a member having a substantially cubical shape, is disposed to face the other surface of the electro-optical device 500 as shown in Figs. 4 to 11.

[0088]

The cover member 620 is preferably made of light shielding resin, metallic material, and the like in order to prevent the leakage of the light in the peripheral region of the electro-optical device 500 and the introduction of the stray light from the peripheral region to the image display region 10a. Since it is preferable that the cover member 620 should function as a heat sink for the plate member 610 or the electro-optical device 500, the cover member 620 is preferably made of materials of relatively high heat conductivity, such as aluminum, magnesium, copper, or an alloy thereof.

[0089]

More specifically, the cover member 620 comprises the convex portion 621, a cover main body 623, a cooling air introducing portion 622, and a cooling air discharging portion 624. The convex portion 621 is used for fixing the plate member 610 and comprises two convex portions 621a and 621b at the locations corresponding to the cover-member-fixing holes 612a and 612b. The convex portion 621 according to the present embodiment is provided to form a portion of the cooling air introducing portion 622 or a tapered portion 622T to be described later (In Fig. 5, although the original convex portion 621 is not shown, it is particularly shown in Fig. 5.).

[0090]

As shown in Figs. 4 to 7, a cover main body 623, which is generally a cubic-shaped member, is arranged between the cooling air introducing portion 622 and the cooling air discharging portion 624 as will be described below. The inside of the rectangular parallelepiped shape, in which the electro-optical device 500 is accommodated, is in the so-called hollow state. Strictly speaking, the cover main body 623 is a member having a lid-free box shape (The "cover" in this expression may be considered to correspond to the plate member 610 described above.).

[0091]

More specifically, the cover main body 623 has a window 625 and a side fin portion 627. The window 625, in which a bottom surface having the box shape (a "top surface" in Fig. 4 or 6) is opened, is a member capable of allowing light to penetrate from the upper side to the lower side in Fig. 6. The light emitted from the lamp unit 1102 within the liquid crystal projector 1100 shown in Fig. 1 can be incident to the electro-optical device 500 through the window 625. In addition, in the cover main body 623 having the window 625, the peripheral region near the image display region 10a in the electro-optical device 500 may be preferably formed to abut against the edge of the window 625 similarly to the description of the window 615 in the plate member 610. In this way, the cover main body 623, more particularly, the

edge of the window 625 can also hold the electro-optical device 500. Further, in this regard, according to the present embodiment, particularly, as similar to the window 615 of the plate 610 described above, a double coated adhesive tape 2 is also provided on the border or the peripheral region of a window 625 of a plate 620, and the plate member 620 are bonded to an electro-optical device 500 by such a double coated adhesive tape 2. These points will also be described below.

[0092]

On the other hand, side fin portions 627 are formed at both sides of the cover main body 623. Herein, the both sides are referred to sides where a cooling air introducing portion 622 and a cooling air discharging portion 624 to be described later do not exist. As shown in Fig. 4 or 6, such side fin portions 627, more particularly, include a protrusion part where a plurality of linear-shaped protrusion portions protrudes from the side in a direction from the cooling air introducing portion 622 to the cooling air discharging portion 624, the linear-shaped protrusion portions being parallel to each other (in Fig. 4, etc., "two" linear-shaped protrusion portions at one side are parallel to each other). In this regard, the surface area of the cover main body 623 and the cover member 620 increases.

[0093]

In addition, as described above, the inner surface of the cover member 620 is abutted against the outer surface of the bent portion 613 in the plate member 610 at the process of adhering the cover member 620 to the plate member 610 (see Fig. 6). In such a case, the "inner surface of the cover member 620" corresponds to the inner surface of the cover main body 623.

[0094]

As well shown in Fig. 4 or 7, the cooling air introducing portion 622 is composed of a tapered portion 622T and a baffle plate 622P. In the present embodiment, the tapered portion 622T has the shape of a substantially triangular prism with its bottom being a right triangle. In addition, the tapered portion 622T has an appearance where one side of the triangular prism in the tapered portion 622T is attached on the one side of the cover main body 623. In this case, the one side of the triangular prism comprises a side interposed between a rectangular portion of the bottom of the triangular prism and a corner portion adjacent thereto. Therefore, the tapered portion 622T has a shape comprising a base portion 622T1 at the highest height of the side of the cover main body 623 and a tip 622T2 at the height gradually lowered therefrom (Herein, the term "height" is a distance in an up-down direction in Fig. 7.

In Fig. 7, a dotted line extending in the up-down direction is represented as a reference.). On the other hand, the baffle plate 622P has a shape of a wall erected along one side between two angles except for the rectangular portion on the bottom of the triangular prism. In terms of the aforementioned "height", the height of the baffle plate 622P is constant at any place between the base portion 622T1 and the tip 622T2 although the height of the tapered portion 622T is gradually lowered from the base portion 622T1 to the tip 622T2.

[0095]

Finally, the cooling air discharging portion 624 comprises a flexible connector leading portion 624C and a rear fin portion 624F as shown in Figs. 4, 5, or 8. The flexible connector leading portion 624C is provided on one side facing the side of the cover main body 623 on which the tapered portion 622T is provided. More specifically, a member having a cross-sectional shape of 'u' on the side is attached by an aperture having a cross-sectional shape of 'u' in the downward direction of Fig. 8 as shown in Fig. 8. A flexible connector 501 connected to the electro-optical device is drawn out from the space surrounded in the shape of "u".

[0096]

On the other hand, the rear fin portion 624F is

provided on the so-called ceiling plate having the cross-sectional shape of 'u' in the flexible connector leading portion 624C. More specifically, as shown in Fig. 4, 5, or 8, the rear fin portion 624F has a plurality of linear-shaped protrusion portions ("four" linear-shaped protrusion portions are disposed in parallel to each other in Fig. 4, etc.), which protrude from the ceiling plate in parallel, so as to correspond to the extending direction of the straight protrusion portions of the side fin portions 627 to be described later. In this way, the surface area of the cover member 620 increases.

[0097]

Since the cover member 620 has the aforementioned construction, the wind blown from the sirocco fan 1300 provided in the liquid crystal projector 1100 flows as shown in Fig. 12 in the vicinity of the mounting case 601 or the cover member 620. Herein, Fig. 12 is a perspective view of an electro-optical device encased in a mounting case and illustrates the typical flow of wind into the electro-optical device encased in the mounting case. In addition, in the liquid crystal projector 1100 shown in Fig. 1, in order to implement the flow of the cooling air as shown in Fig. 12, it is necessary to provide the electro-optical device encased in the mounting case, that is, light valves 100R, 100G, and 100B such that the outlets 100RW, 100GW, and



100BW described above with reference to Fig. 1 face the cooling air introducing portion 622 constituting the cover member 620.

[0098]

Firstly, as the cooling air flows up the tapered portion 622T of the cooling air introducing portion 622, the cooling air is blown to the cover main body 623 by which the surface of the electro-optical device 500 is exposed (see a reference numeral W1). In addition, since the baffle plate 622P is provided to the cooling air introducing portion 622, the cooling air blown in any direction can be almost guided on the tapered portion 622T, and moreover, into the cover main body 623 (see a reference numeral W2). As described above, in accordance with the present embodiment, it is possible to efficiently send the wind to the cover main body 623, and to directly deprive the heat of the electro-optical device 500, that is, to cool down it, and to efficiently deprive the heat accumulated in the cover member 620.

[0099]

The wind, which is in the outside of the baffle plate 622P of the cooling air introducing portion 622, that is, in the side of not facing the tapered portion 622T (see reference numeral W3), or the wind, which reaches the surface of the electro-optical device 500 or the vicinity thereof as described above and then flows by the side of the

cover main body 623, reaches the side fin portion 627. As described above, since the side fin portion 627 has the straight protrusion portions and the surface area of the cover main body 623 increases, it is possible to effectively cool the cover main body 623 or the cover member 620. In addition, as described above, the wind, which reaches the surface of the electro-optical device 500 or the vicinity thereof and then, as it is, blows away from the end portion of the cover main body 623, reaches the rear fin portion 624F (see a reference numeral W1). Since the rear fin portion 624F has the straight protrusion portion and the surface area of the cooling air discharging portion 624 increases as described above, it is possible to effectively cool the cooling air discharging portion 624 and the cover member 620.

[0100]

As describe above, it is possible to effectively cool the mounting case 601 according to the present embodiment using the cooing air as a whole. In addition, such a cooling method is very effective in externally radiating the heat transferred to the electro-optical device 500, the plate member 610, and the cover member 620 in this order as described above. Since the cover member 620 can be effectively cooled, the flow of heat, which is transferred from the electro-optical device 500 to plate member 610 or

the cover member 620 through the bent portion 613, can be effectively maintained at any time. In other words, since the cover member 620 is suitably cooled in a normal state, its function as a heat sink can be maintained at any time. Thus, the heat radiation from the plate member 610, and moreover, from the electro-optical device 500 can be effectively performed as seen from the cover member 620.

[0101]

Therefore, in the present embodiment, since the heat is not excessively accumulated in the electro-optical device 500, the deterioration of the liquid crystal layers 50 and the occurrence of the hot spots can be prevented in advance. Thus, the deterioration of images based on these facts can be greatly reduced.

[0102]

Next, in the present embodiment, particularly, in order to further improve the function of radiating the heat from such an electro-optical device, i.e., function as a heat sink of the plate member 610 and the cover member 620, the plate member 610 includes the following structure. That is, as shown in Fig. 9 or 4, in the plate member 610 according to the present embodiment, the double coated adhesive tape 1 is provided on the border of the window 615, i.e., a portion on which the electro-optical device 500 is placed (in particular, Fig. 7 shows the arrangement of the double

coated adhesive tape 1 as seen from a section. Refer to the inside of a circle shown in Fig. 7). A peripheral region, which is positioned at the circumference of an image display region 10a in the electro-optical device 500, abuts against the border of the window 615, so that the electro-optical device 500 can be bonded to the plate member 610 by such a double coated adhesive tape 1.

[0103]

Further, as shown in Fig. 5 or 4, in the present embodiment, a double coated adhesive tape 2 is also provided on the border of the window 625 of the cover member 620 (In addition, refer to the inside of the circle shown in Fig. 7.)). As mentioned above, similarly to the relationship between the plate member 610 and the electro-optical device 500, it is preferable that the border of the window 625 should abut against the peripheral region of the electro-optical device 500. As a result, in the present embodiment, the cover member 620 is also bonded to the electro-optical device 500 by the double coated adhesive tape 2.

[0104]

Both double coated adhesive tapes 1 and 2 have a rectangular shape surrounding the whole borders of the windows 615 and 625, i.e., the apertures of the windows 615 and 625. As seen from the electro-optical device 500, the double coated adhesive tapes 1 and 2 are provided to

correspond to the whole peripheral region of the electro-optical device 500.

[0105]

Further, the double coated adhesive tapes 1 and 2 according to the present embodiment have the following characteristics. That is, firstly, the double coated adhesive tapes 1 and 2 are made of a material having the heat conductivity of 0.6 [W/m·K] or more, more preferably, 1.0 [W/m·K] or more. The materials satisfying such requirements includes, for example, a material, which contains heat conductive silicon rubber, and a material, which contains the heat conductive silicon rubber and has a multi-layered structure in which the materials of a bonding layer and a layer to be bonded are changed. In addition, the so-called acryl-based heat conductive double coated adhesive tape, which includes acryl rubber as a main body and can additionally include metal oxide or metal nitride, is used. Furthermore, "F-CO TM sheet" supplied by F-CO Co., Ltd. or "TCATT heat conductive adhesive transfer tapes (Product Nos. 9882, 9885, 9890)" supplied by SUMITOMO 3M Co., Ltd. can be used as such double coated adhesive tapes. Secondly, the thicknesses of such double coated adhesive tapes 1 and 2 are in the range of 50 to 200  $\mu\text{m}$ .

[0106]

An electro-optical device encased in a mounting case of

the present embodiment having such configuration has the following effect. Firstly, because the double coated adhesive tapes 1 and 2 have a rectangular shape surrounding the windows 615 and 625, i.e., a shape corresponding to the whole peripheral region of the electro-optical device 500, the double coated adhesive tapes 1 and 2 are bonded to the electro-optical device 500 or the plate member 610 and the cover member 620 over a wide range. Thus, the adhesion between the electro-optical device 500 and the plate member 610 and the adhesion between the electro-optical device 500 and the cover member 620 are securely and tightly attained by the double coated adhesive tapes 1 and 2 having relatively broader area described above. In particular, when the electro-optical device encased in the mounting case is constructed inside a liquid crystal projector 1100, relatively intense tension acts on a flexible connector 501 extended from an electro-optical device. However, because the above-described double coated adhesive tapes 1 and 2 are provided in the present invention, the present invention has an advantage that the electro-optical device 500 encased in a mounting case 601 does not easily deviate from the predetermined position under the relatively intense tension.

[0107]

Secondly, as described above, since the double coated adhesive tapes 1 and 2 are made of a material having higher

heat conductivity, it is possible to efficiently transfer heat from the electro-optical device 500 to the plate member 610, or from the electro-optical device 500 to the cover member 620.

[0108]

Moreover, as described above, when the double coated adhesive tapes 1 and 2 have the relatively wide area in a rectangular shape and the thicknesses of the double coated adhesive tapes 1 and 2 are in the range of 50 to 200 [ $\mu\text{m}$ ], the heat transfer effect described above is much promoted.

[0109]

Preferentially, according to the former 'rectangular shape,' because the adhesion between the electro-optical device and the double coated adhesive tape 1 or 2, or the adhesion between the plate member 610 and the double coated adhesive tape 1 and the adhesion between the cover member 620 and the double coated adhesive tape 2 are made over a wide range, respectively, heat is more efficiently transferred.

[0110]

Further, according to the thickness limitation of the double coated adhesive tapes 1 and 2 of the latter, the heat transfer from the electro-optical device 500 to the plate member 610 or the heat transfer from the same device 500 to the cover member 620 is efficiently accomplished due to the

following conditions. Hereinafter, these will be described with reference to Figs. 13 and 14. Herein, Fig. 13 is a graph qualitatively showing the variation of heat transfer efficiency from the electro-optical device 500 to the plate member 610 (or the cover member 620) and the position deviation amount of the electro-optical device 500 within the mounting case 601 depending on the thickness variation of the double coated adhesive tape 1 (or 2). Further, Fig. 14 is a partially enlarged view of a left bottom circle of four circles shown in Fig. 5, (a) shows a case where the double coated adhesive tape is relatively thin (less than 50 [ $\mu\text{m}$ ]), and (b) shows a case where the double coated adhesive tape is relatively thick (more than 200 [ $\mu\text{m}$ ]).

[0111]

However, the relationship between the thickness of the double coated adhesive tape 1 and the heat transfer efficiency or the amount of positional deviation is similar to that of Fig. 13, the main reason is that a surface of the plate member 610 has random unevenness 610S as shown in Fig. 14. Herein, the unevenness 610S is extremely fine which may occur due to an inherent rough surface of an original material constituting the plate member 610. Further, in this regard, typically, the surface inaccuracy of a dust-proof substrate 400 made of quartz or glass is extremely satisfactory. As shown in Fig. 14, in view of a difference



in height of the unevenness 610S on the surface of the plate member 610, most of the unevenness 610S is presumed to be even.

[0112]

Based on such unevenness 610S, provided that the thickness of the double coated adhesive tape 1 is less than 50 [ $\mu\text{m}$ ], a portion of the double coated adhesive tape 1 is buried in the concave portions of the unevenness 610S due to the unevenness 610S. Thus, the whole surface thereof cannot be bonded to the dust-proof substrate 400. Conversely, as shown in Fig. 14(a) as a reference numeral P, the dust-proof substrate 400 is bonded to the double coated adhesive tape 1 at only the tops of convex portions. Thus, the adhesion between the two becomes weak, and the mount of the positional deviation of the electro-optical device 500 encased in the mounting case 1 becomes relatively big (refer to a dashed line shown in Fig. 13). Further, in such a case, because a gap V between the dust-proof substrate 400 and the plate member 610 is formed due to the unevenness 610S, the heat transfer efficiency between the two decreases. Thus, the amount of heat transfer from the electro-optical device 500 to the plate member 610 decreases (refer to a solid line shown in Fig. 13).

[0113]

On the other hand, provided that the thickness of the

double coated adhesive tape is more than 200 [ $\mu\text{m}$ ], the adhesion between the plate member 610 and the double coated adhesive tape 1 and the adhesive between the dust-proof substrate 400 and the double coated adhesive tape 1 are effectively made respectively because the thickness is enough to compensate for the difference between the high and low of the unevenness 610S. However, in such a case, elastic force, which is shown in Fig. 14(b) as a reference numeral F, generates in the double coated adhesive tape 1, so that a relative positional difference between the plate member 610 and the dust-proof substrate 400 may occur (refer to a dashed line shown in Fig. 14(b)). The amount of positional deviation monotonously increases depending on the thickness of the double coated adhesive tape 1 (refer to a dashed line shown in Fig. 13). Further, the thicker the double coated adhesive tape 1 becomes, the longer a heat transfer path becomes. Thus, it is considered that heat transfer efficiency decreases (refer to a solid line shown in Fig. 13).

[0114]

Further, for the convenience of explanation, as described above, although Fig. 14 is a partially enlarged view of a left bottom circle of four circles shown in Fig. 5, it is clear that the aforementioned situation can be similarly applied to all four circles as shown in Fig. 5.

[0115]

In such conditions and a graph shown in Fig. 13, when the thickness of the double coated adhesive tapes 1 (or 2) according to the present embodiment is in the range of 50 to 200 [ $\mu\text{m}$ ], it is most suitable to certainly bond the plate member 610 (or the cover member 620) to the electro-optical device 500 and to effectively transfer heat from the latter to the former.

[0116]

Further, because the relationship between the thicknesses of the double coated adhesive tapes 1 and 2 and the heat transfer efficiency or the amount of positional deviation described above mainly depends on the unevenness 610S described above, it is possible to properly change the thickness of the double coated adhesive tapes 1 and 2 in accordance with the size of the unevenness 610S, i.e., the degree of roughness of the outmost surface of the plate member 610 or the cover member 620. Namely, if the surface roughness is small, the above-described inconvenience does not occur even if much thinner double coated adhesive tape 1 or 2 is used. Furthermore, if the surface roughness is large, much thicker double coated adhesive tape 1 or 2 can be suitable for use.

[0117]

Such a point is the core when the thickness of the

"double coated adhesive tape" according to the present invention is very suitably determined. Although the above-described limitation of "the range of 50 to 200  $\mu\text{m}$ " has been proposed as the most suitable value to correspond to the difference in height of the unevenness 610S, it is possible to adjust the thickness in accordance with the degree of the surface roughness if necessary. Further, it is not important that the adjusted value is in excess of the range of the aforementioned numeral value. The present invention also includes such a case.

[0118]

As described above, the electro-optical device 500 is more certainly and tightly bonded to the plate member 610 and the cover member 620, and heat transfer from the former to the latter efficiently proceeds. Thus, it is possible to make every effort to prevent the positional deviation of the electro-optical device 500 in the mounting case 601 and to effectively cool the electro-optical device 500. As a result, the deterioration of image quality due to the deterioration of liquid crystal does not occur.

[0119]

Moreover, in accordance with the plate member 610 according to the above-described embodiment, as mentioned above, a process for making the its outmost surface with black color is performed. However, in view of the

relationship between such a point and the double coated adhesive tape 1, it is preferable to effectively attain the operation and effect according to the present invention if the following configuration is employed.

[0120]

That is, in such a case, in order to make the outmost surface of the plate member 610 with black color, it is preferable to perform a plating process using materials such as nickel, chrome, zinc, etc. after performing a blast process on the surface of the plate member 610 (hereinafter, referred to Ni plating as a representative). In this regard, firstly, because random unevenness and relatively big unevenness is formed on the surface of the plate member 610 due to the blast process (see Figs. 14(a) and 14(b)), it is possible to effectively attain the operation of preventing light reflection described above. Further, as compared with a case of the painting process to obtain black color, it is possible to strongly bond the plate member 610 to the double coated adhesive tape 1 using Ni plating. In accordance with the painting process, paint is easily exfoliated from the surface of the plate member 610. In the present embodiment, because there is no such trouble, the plate member 610 is more certainly and tightly bonded to the double coated adhesive tape 1. As a result, the plate member 610 can be more certainly and tightly bonded to the

electro-optical device 500.

[0121]

In addition, although the explanation for making the outmost surface of the cover member 620 with black color is omitted, it is desirable that the cover member 620 also have shading capacity to prevent the leakage of light in the peripheral region of the electro-optical device 500 and to prevent stray light from the peripheral region from being incident on the image display region 10a. Thus, in the present invention, as similar to the plate member 610 described above, it is preferable that a painting process, a plating process, etc. should be performed on the cover member 620 to coat the outmost surface thereof with black color. In such a case, in consideration of the relationship between the cover member 620 and the double coated adhesive tape 2, as described above about the plate member 610, it is also desirable that a blast process and a Ni plating process should be performed on the surface of the cover member 620 to coat the outmost surface of the cover member 620 with black color.

[0122]

Further, in the embodiment described above, although the double coated adhesive tape 1 or 2 has a rectangular shape surrounding the windows 615 and 625, the present invention is not limited to this shape. For example, it is

possible to employ shapes shown in Figs. 15 and 16. Herein, Figs. 15 and 16 are similar to Fig. 9 except for a planar shape of the double coated adhesive tape. In addition, the plate member 610 to which the double coated adhesive tape is bonded will be described below.

[0123]

First, in Fig. 15, double coated adhesive tapes 11 are provided at only the vertical regions of the window 615. So to speak, such double coated adhesive tapes 11 have a stripe shape. Moreover, instead of an aspect shown in Fig. 15, it is preferable that the double coated adhesive tapes should be provided at only the horizontal regions of the window 615. Further, in Fig. 16, double coated adhesive tapes 12 are provided to correspond to only four corners of the window 615. However, in such a case, it is not desirable that each of the double coated adhesive tapes 12 has so small area. If the area of the double coated adhesive tapes 12 is so small, i.e., the double coated adhesive tapes 12 are "point-bonded", it is impossible to very suitably maintain the adhesion between the plate member 610 and the electro-optical device 500. Coping with such a problem, it is desirable that the double coated adhesive tapes according to the present invention have a predetermined area or more, thereby enabling the plate member 610 to be "area-bonded" with the electro-optical device 500. Further, it is

possible to determine whether an adhesion state is the "point-bonding" state or the "area-bonding" state by considering the size of the electro-optical device (more specifically, the size of the TFT array substrate 10, the size of the counter substrate 20, and the size of the dust-proof substrate 400, in particular, the size of the peripheral region), or the size of the plate member 610, and the size of the unevenness 610S or the surface accuracy of the plate member 610 as a primary factor and a matter of design.

[0124]

In various modifications, as compared with that of Fig. 9, the amount of the double coated adhesive tapes used can be depressed. Thus, cost can come down as much as the reduction in the amount of the tapes used. Further, the modifications described above can also be applied to the cover member 620.

[0125]

Moreover, in the above-described embodiment, although the adhesion between the electro-optical device 500 and the plate member 610 and the adhesion between the electro-optical device 500 and the cover member 620 are made by the double coated adhesive tapes 1 and 2, the present invention is not limited to such an aspect. For example, in the inner portions of the circles shown in Fig. 7 or regions where the



double coated adhesive tapes 1 and 2 are provided in Figs. 4 and 9, it is preferable that a mold material such as an adhesive made of silicon resin, etc., more specifically, silicon RTV rubber should be provided instead of the double coated adhesive tapes 1 and 2.

[0126]

The present invention is not limited to the aforementioned embodiments, but it can be modified without departing from the scope and spirit of the present invention obtained by claims and the teachings of the specification. The modified electro-optical device encased in the mounting cases and projection display apparatuses also belong to the technical scope of the present invention. The electro-optical device includes an electrophoresis apparatus, an electroluminescence apparatus, and the like as well as a liquid crystal panel.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a plan view illustrating an embodiment of a projection liquid crystal apparatus according to the present invention.

[Fig. 2]

Fig. 2 is a plan view illustrating an embodiment of an electro-optical device according to the present invention.

[Fig. 3]

Fig. 3 is a cross-sectional view taken along the line H-H' shown in Fig. 2.

[Fig. 4]

Fig. 4 is an exploded perspective view illustrating an electro-optical device together with a mounting case according to an embodiment of the present invention.

[Fig. 5]

Fig. 5 is a front view of the electro-optical device encased in the mounting case according to the embodiment of the present invention.

[Fig. 6]

Fig. 6 is a cross-sectional view taken along the line X1-X1' shown in Fig. 5.

[Fig. 7]

Fig. 7 is a cross-sectional view taken along the line Y1-Y1' shown in Fig. 5.

[Fig. 8]

Fig. 8 is a back view shown from the direction of Z1 shown in Fig. 5.

[Fig. 9]

Fig. 9 is a front view of a plate member constituting the mounting case according to the embodiment of the present invention.

[Fig. 10]

Fig. 10 is a back view shown from the direction of Z2

shown in Fig. 9.

[Fig. 11]

Fig. 11 is a side view shown from the direction of Z3 shown in Fig. 9.

[Fig. 12]

Fig. 12 is a perspective view of the electro-optical device encased in the mounting case according to the embodiment of the present invention and illustrates the flow of air to the electro-optical device encased in the mounting case.

[Fig. 13]

Fig. 13 is a graph qualitatively showing the variation of heat transfer efficiency from an electro-optical device to a plate member or a cover member and the position deviation amount of the electro-optical device within the mounting case depending on the thickness variation of a double coated adhesive tape.

[Fig. 14]

Fig. 14 is a partially enlarged view of a left bottom circle of four circles shown in Fig. 5, (a) shows a case where the double coated adhesive tape is relatively thin (less than 50 [ $\mu\text{m}$ ]), and (b) shows a case where the double coated adhesive tape is relatively thick (more than 200 [ $\mu\text{m}$ ]).

[Fig. 15]

Fig. 15, as similar to Fig. 9, is a diagram showing another aspect of double coated adhesive tapes (stripe shape) in plan view.

[Fig. 16]

Fig. 16, as similar to Fig. 9, is a diagram showing a further aspect of double coated adhesive tapes (which are scattered at four corners) in plan view.

[Reference Numerals]

1, 2: DOUBLE COATED ADHESIVE TAPE  
10: TFT ARRAY SUBSTRATE  
20: COUNTER SUBSTRATE  
400: DUST-PROOF SUBSTRATE  
50: LIQUID CRYSTAL LAYER  
500: ELECTRO-OPTICAL DEVICE  
601: MOUNTING CASE  
610: PLATE MEMBER  
615: WINDOW  
610S: UNEVENNESS  
620: COVER MEMBER  
625: WINDOW  
622: COOLING AIR INTRODUCING PORTION  
622T: TAPERED PORTION  
622P: BAFFLE PLATE  
623: COVER MAIN BODY  
627: SIDE FIN PORTION

624: COOLING AIR DISCHARGING PORTION

624F: REAR FIN PORTION

100R, 100G, 100B: LIGHT VALVE

1100: LIQUID CRYSTAL PROJECTOR

1102: LAMP UNIT

[Name of Document]        ABSTRACT

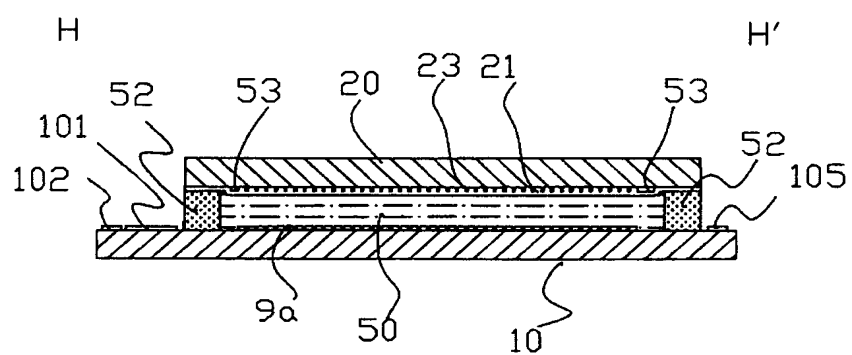
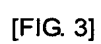
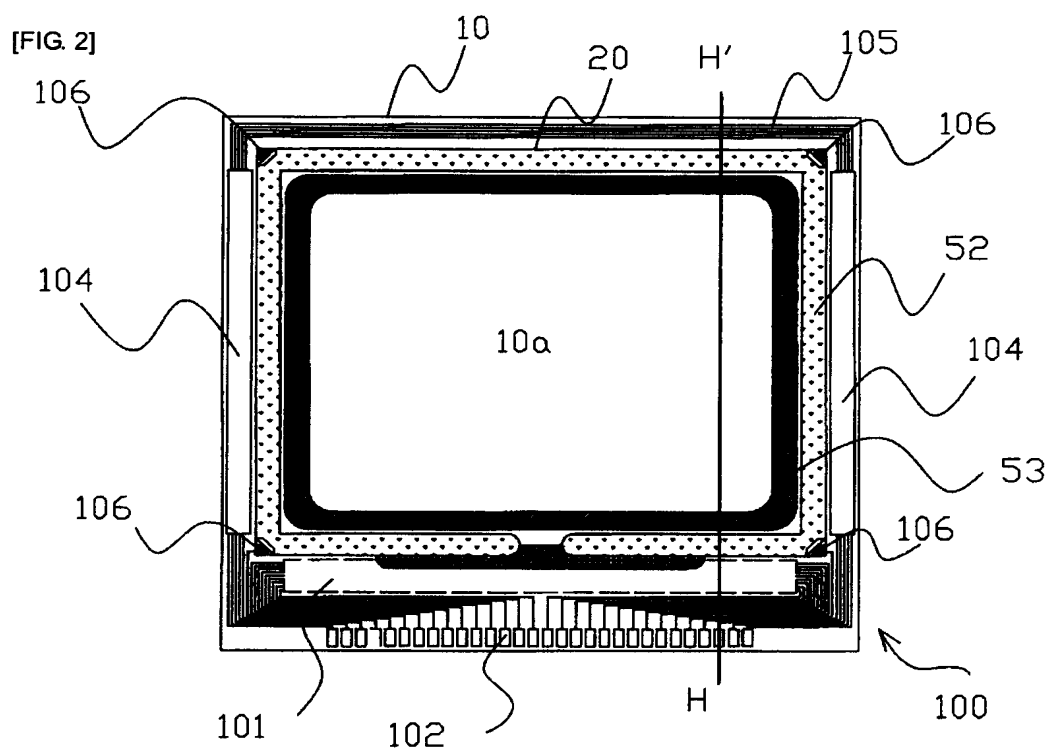
[Abstract]

[Object]    To provide an electro-optical device encased in a mounting case in which the rise in temperature of an electro-optical device is efficiently depressed even when relatively intense projection light is incident thereon.

[Solving Means]    An electro-optical device 500 encased in a mounting case having an image display region on which projection light from a light source is incident includes a mounting case 601 comprising a plate 610 disposed to face one surface of the electro-optical device and a cover 620 for covering the electro-optical device, a portion of the cover abutting against the plate, wherein the mounting case accommodates the electro-optical device by holding at least a portion of the peripheral region positioned at the circumference of the image display region of the electro-optical device with at least one of the plate and the cover. Then, at least one of the plate and the cover is bonded to the electro-optical device by bonding means 1 or 2.

[Selected Figure]        Fig. 4

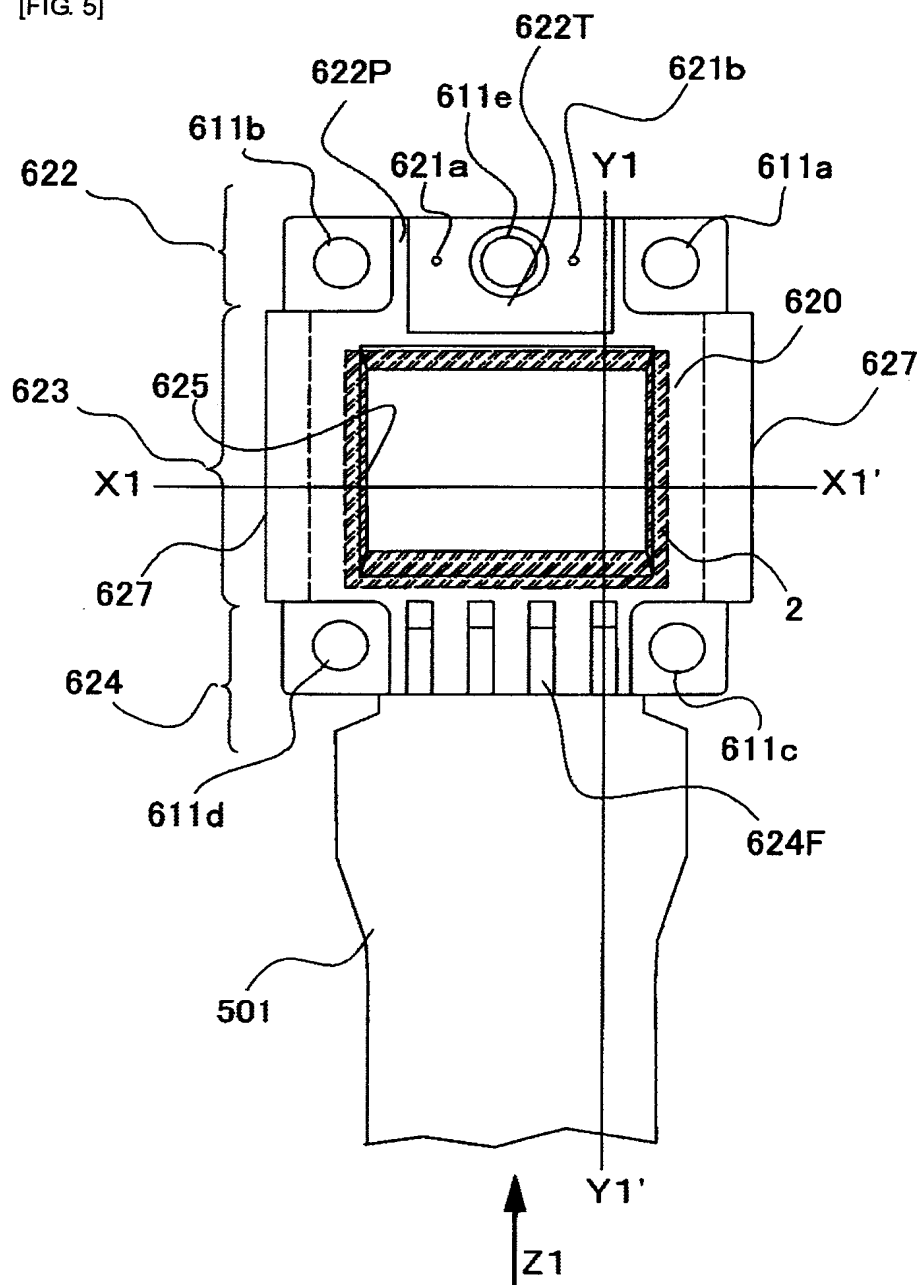




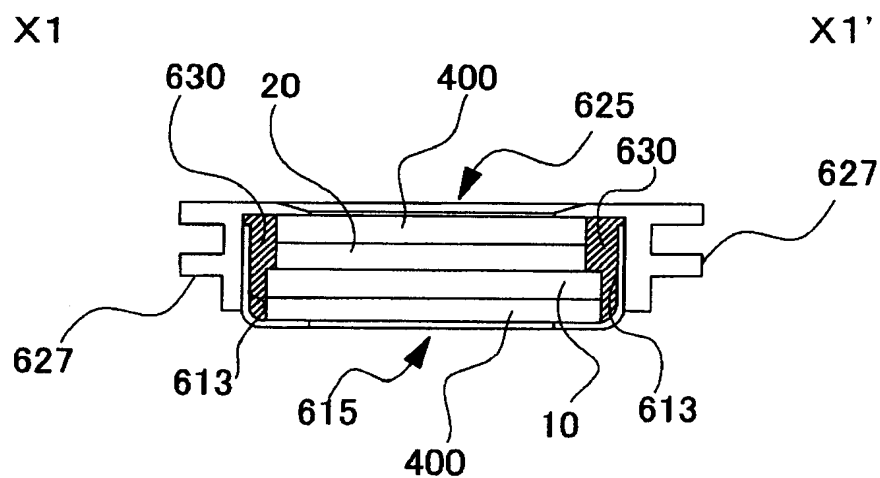




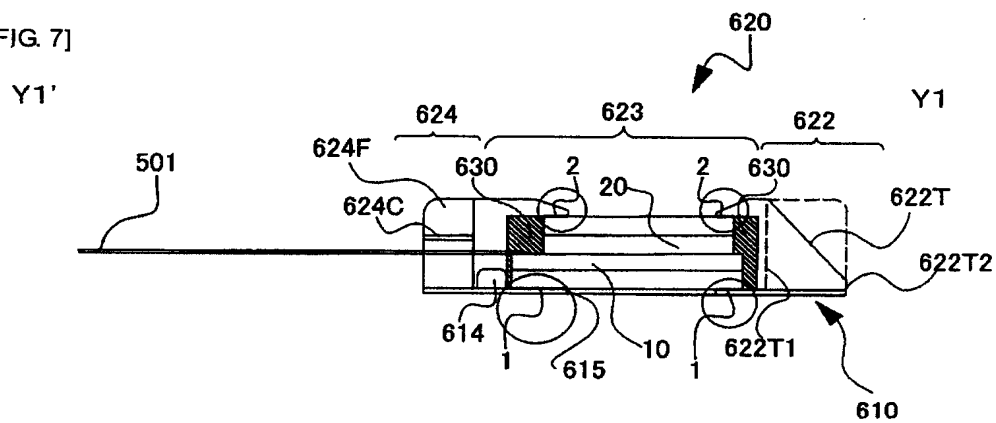
[FIG. 5]



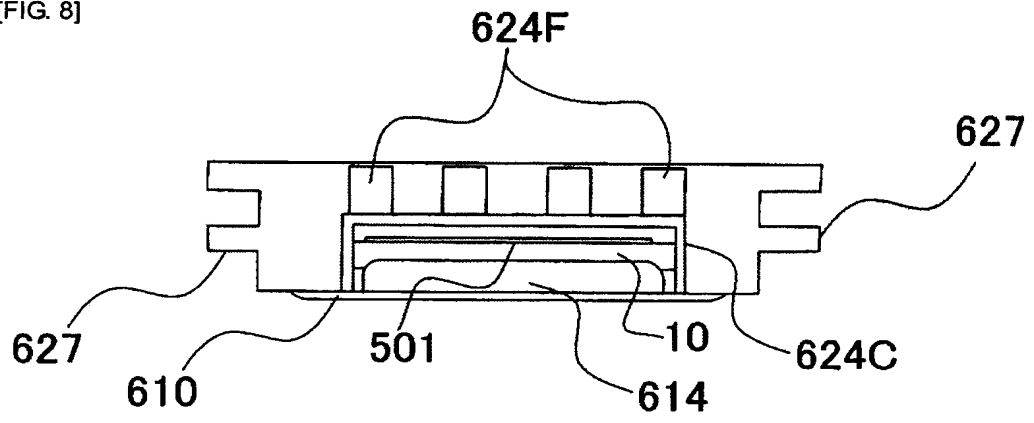
[FIG. 6]



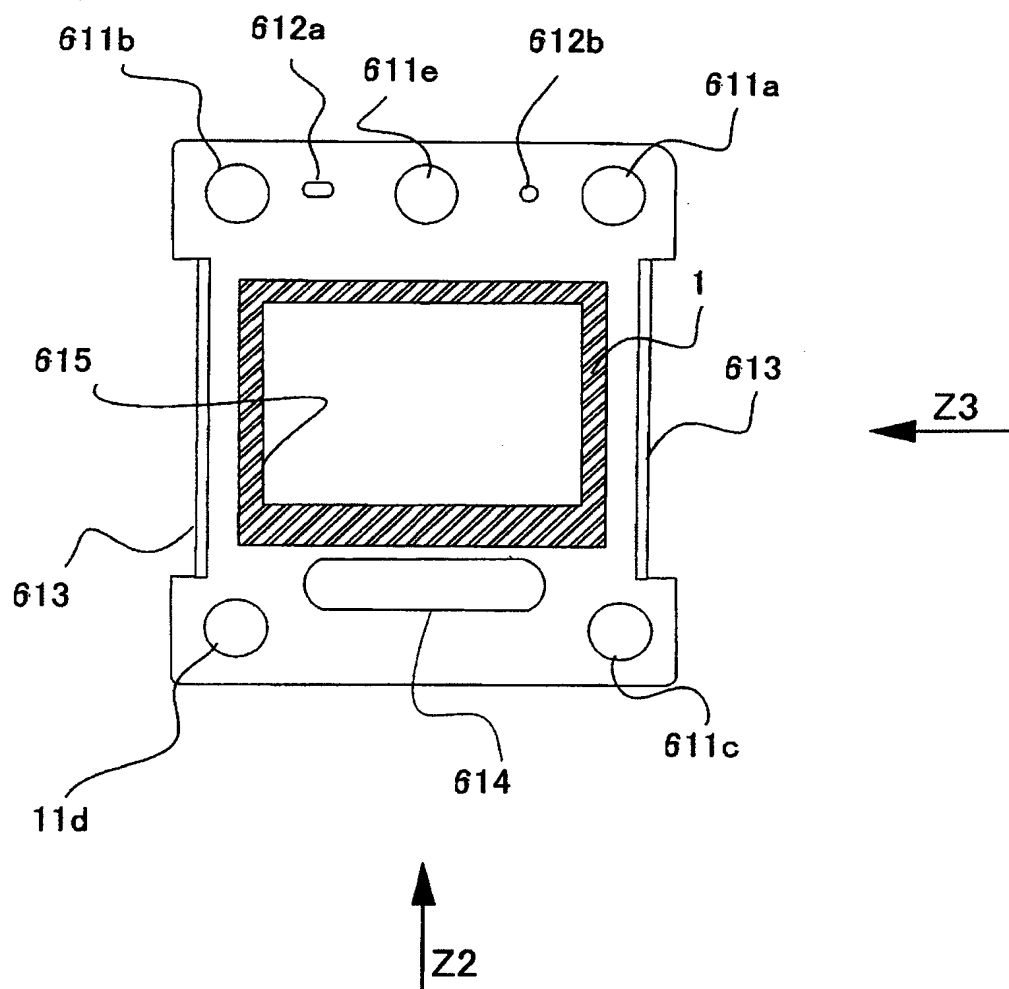
[FIG. 7]



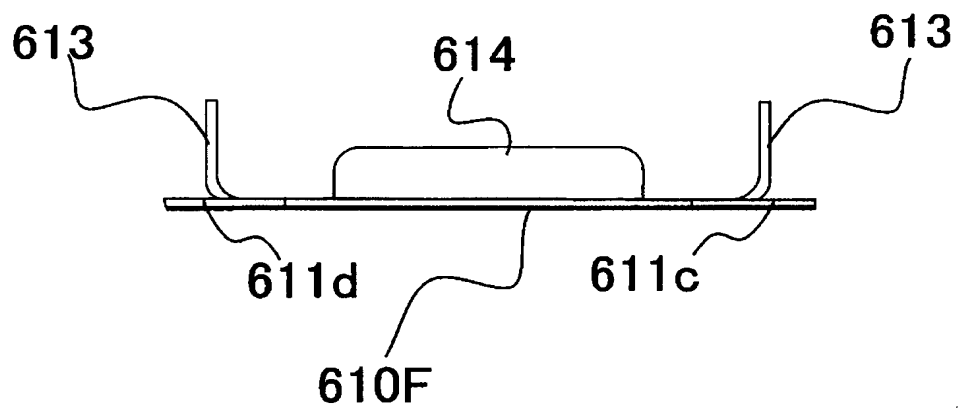
[FIG. 8]



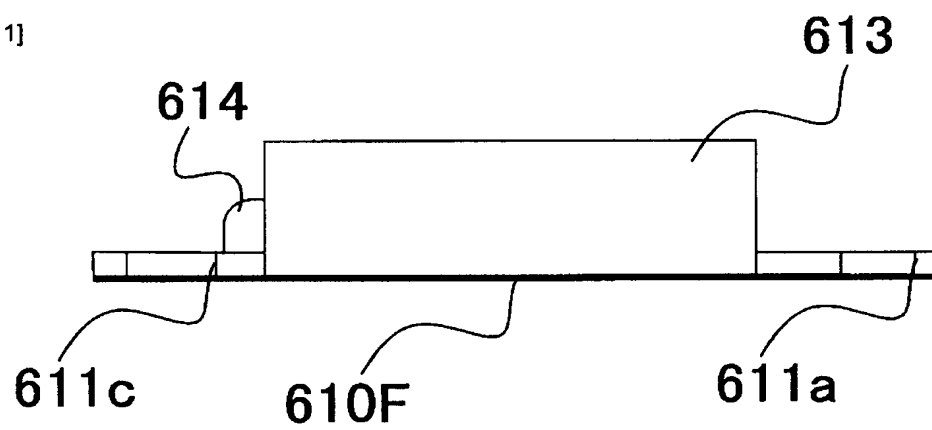
[FIG. 9]



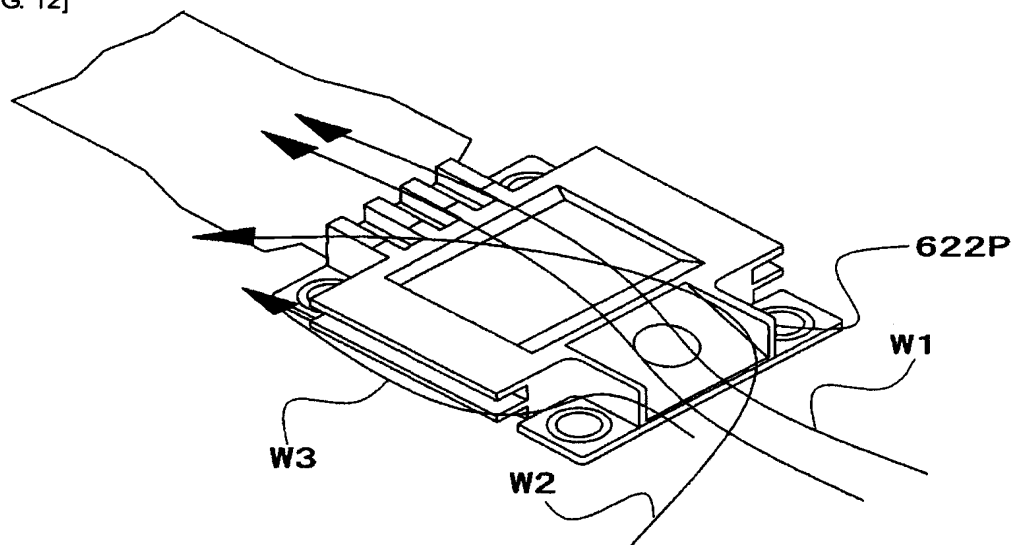
[FIG. 10]



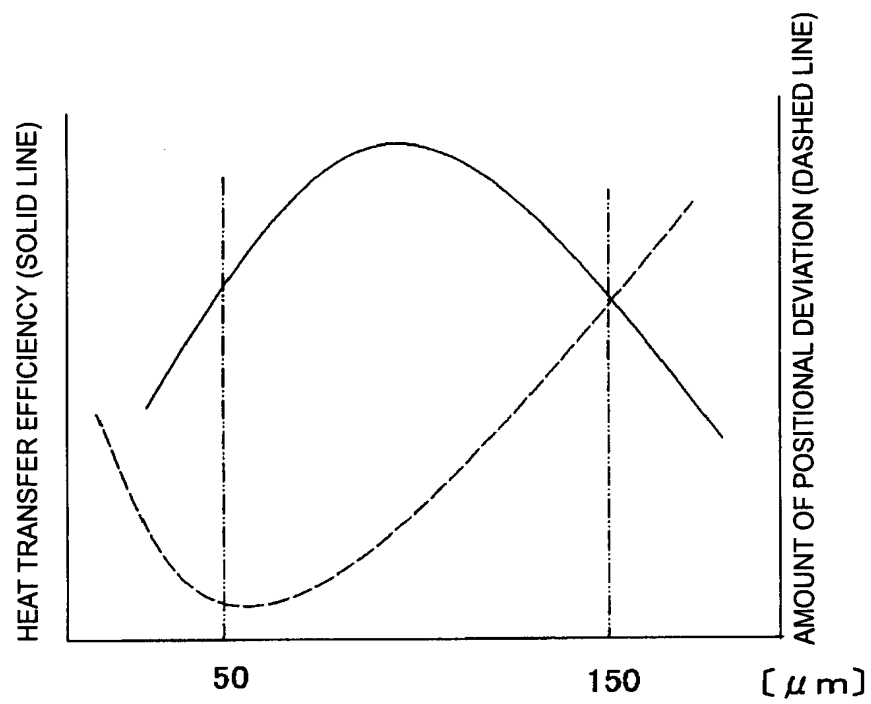
[FIG. 11]



[FIG. 12]

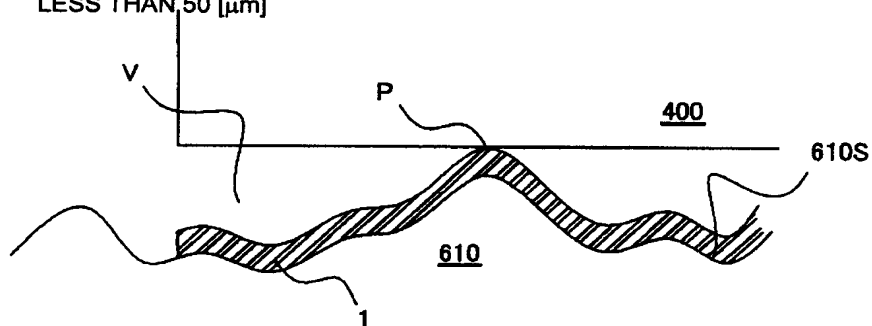


[FIG. 13]

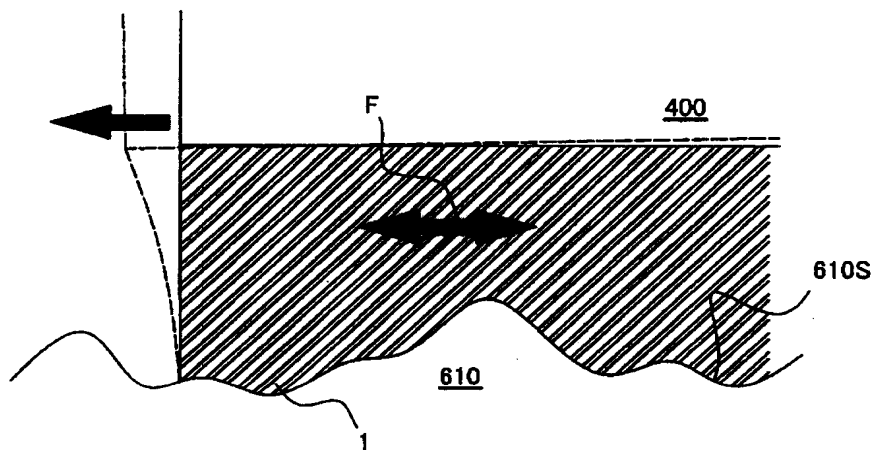


[FIG. 14]

(a) WHEN THICKNESS OF DOUBLE COATED ADHESIVE TAPE IS  
LESS THAN 50 [ $\mu\text{m}$ ]

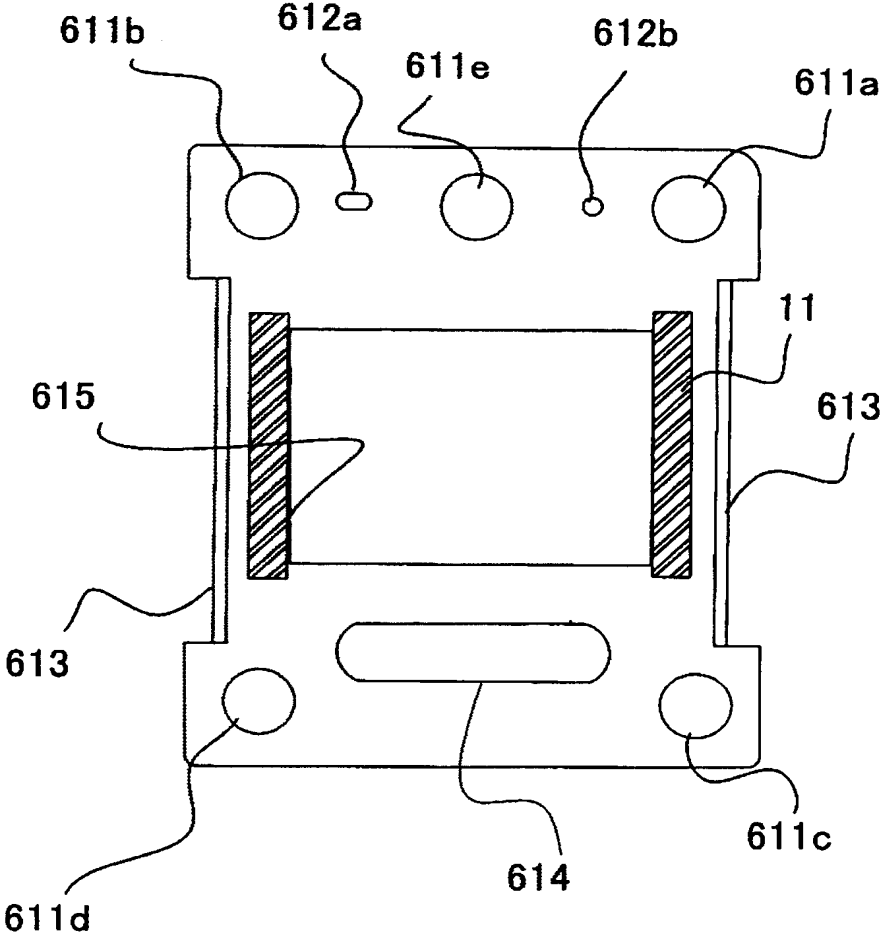


(b) WHEN THICKNESS OF DOUBLE COATED ADHESIVE TAPE IS  
MORE THAN 200 [ $\mu\text{m}$ ]





[FIG. 15]



[FIG. 16]

